

## Research Notes

Program Steering Committee (PSC): Geotechnical/Structures

May 2014

Title: Time Dependent Deflection of In-Span Hinges of Prestressed Concrete Structures during Construction

Task Number: 1946

Start Date: 07/11/2011

Completion Date: 06/01/2014

Task Manager: Hamid Ikram, Transportation Engineer

[hamid\\_ikram@dot.ca.gov](mailto:hamid_ikram@dot.ca.gov)

---

### TITLE:

Time Dependent Deflection of In-Span Hinges of Prestressed Concrete Structures during Construction

The goal of this study is to assess the simple Caltrans procedure MTD (Memo to Designers) 11-34 for measuring the deflection of in-span hinges and make necessary recommendations in light of the analytical and field data.

---

### WHAT IS THE NEED?

To accommodate thermal movements in box girder bridges, the in-span hinges are used in parts of the spans with relatively small gravity and live load movements at approximately one-fifth to one-quarter of the span length. The hinge leads to a short and long cantilever, with the long cantilever eventually bearing on the short cantilever, after removal of the forms. Post-tensioning force tends to lift the bridge off the false work and leads to non-uniform longitudinal profile for the bridge. A reasonably accurate estimate of the upward deflection is needed.

Caltrans has developed practical methods to estimate the profile of the short cantilever prior to load transfer from the long cantilever in the span. Caltrans Memo to Designers (MTD) 11-34 includes a simple equation to estimate the immediate deflection and incorporates two tables to adjust the deflection to account for time-dependent behavior of concrete members due to creep and shrinkage. The proposed study will generate analytical and experimental data that will allow in-depth, reliable evaluation and refinement of the MTD 11-34 method and adjustment factors.

The deflection not only varies with time, but it is also a function of the seasonal variation of the ambient temperature and relative humidity (RH). Existing concrete creep and shrinkage models generally assume constant RH and temperature over the course of analysis. In the proposed study the effect of variable RH and temperature will be investigated and reflected in the adjustment factors to account for time-dependent deflections.

### WHAT ARE WE DOING?

To accomplish the objectives of this study, analytical and field studies of post-tensioned concrete bridges with in-span hinges will be performed. The analytical studies will include comprehensive assessment of the critical parameters, by analyzing many bridge hinges

representing a practical range of dimensions and configurations that are encountered in real bridges. The study will include literature search on relevant topics, identify five bridges in California for field measurement and conduct finite element (FE) analysis of the five bridges using a finite element analysis program ABAQUS.

The primary data to be collected in the field will be vertical deflection of the short cantilevers in the in-span hinges. The deflections will be measured using a portable laser distance finder (Accuracy of 0.04 inch) instead of using surveying equipment (Accuracy of 0.1 inch). Analytical model will be calibrated and used to determine the deflections and time-dependent adjustment factors for a large number of bridges with different geometries and configurations. Once the field data and FE analysis data are available, the MTD 11-34 equations and time adjustment tables will be refined to more accurately match the field data and results of FE studies for a variety of bridges. A final report will be prepared summarizing the investigations and recommendations.

### **WHAT IS OUR GOAL?**

The goal of this study is to assess the simple Caltrans procedure MTD (Memo to Designers) 11-34 for measuring the deflection of in-span hinges and make necessary recommendations in light of the analytical and field data.

### **WHAT IS THE BENEFIT?**

The proposed study is expected to improve the post-tensioned bridges and provide a smoother ride for travelling public over the in-span hinges. Because of a large number of post-tensioned multi-frame bridges in California many California highways will benefit from the results of this research. Also by properly accounting for the hinge curl and adjusting the road profile, the vehicle impact at hinges could be reduced and the resulting damage and maintenance work will be minimized.

### **WHAT IS THE PROGRESS TO DATE?**

The data collection on four bridges in California has been completed, while the data collection on the fifth bridge is currently in progress. The table below shows bridge location, and data collection start and end dates for five bridges in California.

Bridge Project Title	Location	Data Collection Start Date	Data Collection End Date
SAN LUIS REY RIVER BRIDGE	San Diego	October, 2011	March, 2012
N170-N5 CONNECTOR	Los Angeles	September, 2012	April, 2013
BRADLEY OVERHEAD	Merced	October, 2012	January, 2013
EB WILSHIRE BLVD ON-RAMP OC	Los Angeles	May, 2013	October, 2013
DEL PASO PARK OVERHEAD	Sacramento	March, 2013	In Progress

Also the processing of new data and modeling on the ABAQUS and SAP2000 software programs is currently in progress. Contractor continues updating the project website with current information.

<http://wolfweb.unr.edu/homepage/saiidi/caltrans/hingecurl.html>

A no-cost time extension request is in progress to extend the end date of this contract to August 31, 2015.